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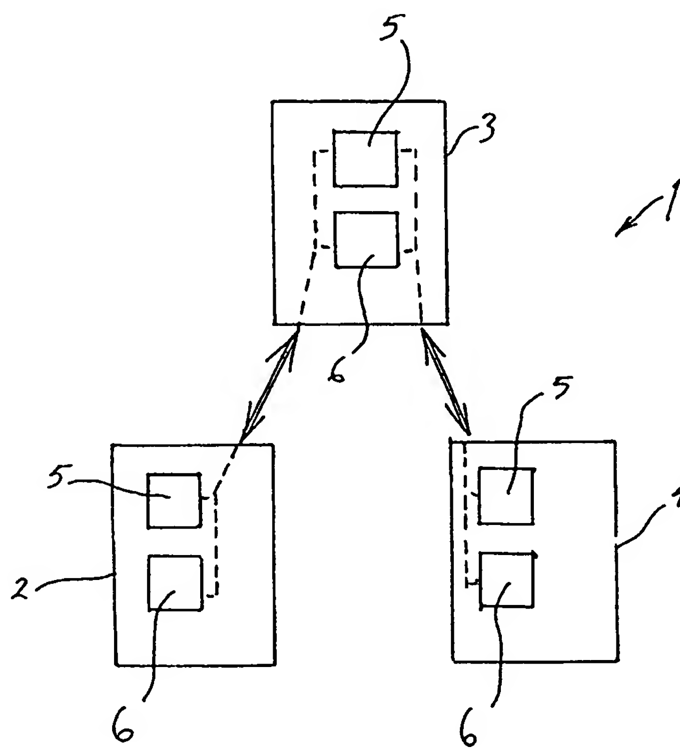
(54) Title: A COMMUNICATIONS NETWORK AND A DEVICE FOR USE IN THAT NETWORK

(57) Abstract

A mobile or cellular telephone communications network (1) includes a plurality of network nodes in the form of mobile telephones (2, 3 and 4). Each telephone has at least one public channel (5) for routing data within the network. The telephones also have at least one private channel (6) for originating and receiving data for its respective node. Each telephone is dynamically reconfigurable such that its connection with one or more other nodes within the network is dynamically allocated when the node first enters the network.



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TITLE: A COMMUNICATIONS NETWORK AND A DEVICE FOR USE IN THAT NETWORK

Field of the Invention

The present invention relates to a communications network and in particular to a communications network including a plurality of network nodes.

The invention has been developed primarily for a mobile or cellular communications network and will be described hereinafter with reference to that application. It will be appreciated, however, that the invention is not limited to that particular field of use and is also suitable for other wireless and land line communications.

Background of the Invention

Present generation telecommunications networks typically rely on base stations having a cell size (that is, a transmission and reception footprint) of the order of one kilometre in radius. Smaller cells are occasionally used to fill transmission and reception gaps caused by terrain or structural interference. Large cells in telecommunications networks have worked adequately with previous generation protocols and transmission rates. However, next and future generation networks have substantially increased bandwidth requirements due to increases in the number of users, user population per unit area and the users' telecommunications demands for higher data rates. Unfortunately, signal quality in RF networks falls logarithmically with distance from a transmitter/receiver.

One way to reconcile this need for higher bandwidth to larger numbers of users is to reduce the size of transmission and reception cells from about one kilometre in radius

to hundreds of metres. Such small cell telecommunications networks are sometimes referred to as microcellular networks. Unfortunately, smaller cell size and the corresponding use of relatively low power microcellular base stations can lead to increased rates of service outage due to more nulls in the coverage area. The resultant poor service quality is an impediment to customer acceptance of such new networks.

To avoid these problems, it is necessary to ensure easy deployment of the requisite base stations so that large numbers can be deployed quickly as the network is initially installed and additional elements can quickly and flexibly added to network to minimise holes in the service area after installation. Known techniques of base station use necessitates an enormous capital cost and significant ongoing maintenance costs.

Moreover, the number of base stations deployed must be sufficient to accommodate the peak demand, notwithstanding that that peak demand will only need be required infrequently over a given day. To further complicate matters, the peak demand for different base stations will not only vary in quantity, but in time of occurrence. For example, for a base station in a city's CBD the peak demand will occur during business hours, while for a base station in a residential suburb, the peak demand will more likely occur out of business hours. This geographic and temporal dynamic demand for bandwidth is a significant concern and contributes greatly to the cost of existing networks.

Disclosure of the Invention

It is an object of the present invention, at least in the preferred embodiments to overcome or substantially ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

According to a first aspect of the invention there is provided a communications network including a plurality of network nodes each having at least one public channel for routing data within the network and at least one private channel for originating and receiving data for its respective node, each node being dynamically reconfigurable such that its connection with one or more other nodes within the network is dynamically allocated when the node first enters the network.

Preferably, at least one of the plurality of nodes is interconnected to a plurality of nodes simultaneously. More preferably, the at least one node is connected to a.plurality of adjacent nodes to facilitate transmission power requirements.

Preferably also, the at least one public channel and the at least one private channel function in duplex mode. In other embodiments, however, simplex operation is utilised. That is, the at least one public channel and the at least one private channel operate discretely and sequentially on a single channel or multiple channels.

In a preferred form, each node includes an in-circuit reconfigurable gate array processor for configuring respective nodes. More preferably, the reconfigurable gate array processor includes a plurality of logic cells and operates in real time. In other embodiments, however, the array processor operates partially in real time, while in still further embodiments some operations are performed in real time and others partially in real time. Even more preferably, the reconfigurable gate array processor is in electrical communication with and configured by a processor executing a software program.

Preferably also, the reconfigurable gate array processor operates as a plurality of digital transceivers and routing circuits.

Preferably, the processor controlling the reconfigurable gate array processor is in electrical communication with a non-volatile memory means for providing predetermined access to a plurality of node configuration templates, the microprocessor selectively implementing one of the plurality of templates in the reconfigurable gate array processor logic cells.

Preferably also, the circuit configuration templates are loaded into the reconfigurable gate array processor under software control for allowing channel equalisation algorithms to be adapted in real time to match fluctuating channel conditions. Preferably also, the array processor includes reconfiguration decision control circuitry wherein at least some components of this circuitry are implemented as reconfigurable logic within the array processor.

Preferably, the processor controlling the reconfigurable gate array processor is also implemented within the array processor to reduce the need for off chip routing of signals between the processors.

In a preferred form, the nodes configured for routing or carriage services such that when the node carries en route through traffic destined for nodes other than the current node, received signals are regenerated and retransmitted to the next node in the network route. Preferably also, the nodes are dynamically reconfigured to accommodate a plurality of telecommunication protocols or media access protocols. More preferably, the nodes are dynamically reconfigured to accommodate a plurality of air interface standards to allow a user to roam between heterogenous network service areas.

Preferably, the reconfigurable gate array processor operates parallel digital transceivers such that each active connection to another network node has allocated to it at least one of those transceivers.

Preferably also, the reconfigurable gate array processor establishes a plurality of signal circuits for each active node connection. More preferably, each signal circuit is comprised of a serially generated sequence of sub-circuits that progressively process the incoming data signal to provide the required response. In some cases the desired response will be to retransmit the data signal, while in other cases to ignore the data signal and take no further action.

In a preferred form, the reconfigurable gate array processor is configured to implement a large number of parallel receivers, at least one for each active node.

Preferably, the network operates with a radio frequency carrier. More preferably, the network is cellular. Even more preferably, the network is configured for digital communication. However, in other embodiments, use is made of analog carriers.

Preferably also, the plurality of nodes are movable. More preferably, at least some of the nodes are stationary. Even more preferably, the movable nodes are respective mobile telephones and the stationary nodes are respective base stations.

In other embodiments the movable nodes include respective mobile pagers.

Preferably, the reconfigurable gate array processor is configured to operate as a OFDMA/CDMA transceiver.

Preferably also, the nodes include an antenna having an output electrically connected to a bypass filter, the filter providing an output signal which is passed through a low noise amplifier and an A/D converter.

In a preferred form, the templates allow the reconfigurable gate array processor to dynamically perform one or more of the following functions: n-point inverse fast Fourier transform; inverse n-point discrete Fourier transform; a pseudo random code generation; correlation; channel equalisation; wavelet transformation; DPSK modulation and demodulation; QPSK modulation and demodulation; GMSK modulation and demodulation; PPM modulation and demodulation; PWM modulation and demodulation; M-ary modulation and demodulation; direct digital frequency synthesising; filtering; control of the front end media access circuits; and forward error correction.

Preferably, each node is dynamically reconfigurable such that its connection with one or more other nodes within the network is dynamically allocated in response to one or more of the following:

the geographic location of the node with respect to any other node; and

the number and bandwidth of the public and private channels.

More preferably, the dynamic allocation is continuously carried out.

According to a second aspect of the invention there is provided a communications device for a communications network including a plurality of communication nodes, the device including:

first means for establishing communication between the device and at least two nodes in the network and for receiving from those nodes a first data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

second means for generating a second data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

third means for providing the first data signal to one of the at least two nodes such that the data signal is communicated to the node in the network which corresponds to the address information; and

fourth means for receiving the first data signal and, if the address information corresponds to the device, extracting the message information, or otherwise communicating the first signal to the other of the at least two nodes.

Preferably, the first means establishes communication with more than two nodes and in circumstances where the fourth means communicates the first signal, that communication is provided to only one of the other nodes.

Preferably also, the first data signal is coded to prevent extraction of the message information by a node other than that corresponding to the address information.

In a preferred form, the device is a mobile telephone and the nodes are like mobile telephones.

According to another aspect of the invention there is provided a method of communication utilising a communications device in a communications network including a plurality of communication nodes, the method including the steps of:

establishing communication between the device and at least two nodes in the network and for receiving from those nodes a first data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

generating a second data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

providing the first data signal to one of the at least two nodes such that the data signal is communicated to the node in the network which corresponds to the address information; and

receiving the first data signal with the device and, if the address information corresponds to the device, extracting the message information or, otherwise, communicating the first signal to the other of the at least two nodes.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a communications network according to the invention;

Figure 2 is a block diagram of one type of node of the network of Figure 1; and

Figure 3 is a block diagram of another node of the network of Figure 1.

Preferred Embodiments of the Invention

Referring to Figure 1, a mobile or cellular telephone communications network 1 includes a plurality of network nodes in the form of mobile telephones 2, 3 and 4. Each telephone has at least one public channel, which is designated by the reference numeral 5, for routing data within the network. The telephones also have at least one private channel, which is designated by the reference numeral 6, for originating and receiving data for its respective node. Each telephone is dynamically reconfigurable such that its

connection with one or more other nodes within the network is dynamically allocated when the node first enters the network.

The public channel of each node carries en route through traffic destined for nodes other than the current node. The signals are regenerated and retransmitted to the next nodes in the network route. The private channel of each node is for originating user communications and for receiving user communications with the current node as source or final destination respectively. In this embodiment the private and public channels each operate in full duplex, that is to say each has receiver and transmitter circuits which operate concurrently.

While in this embodiment node 2, 3 and 4 are each mobile telephones, in other embodiments the nodes are other wireless transceivers or network base stations. As will be appreciated, the mobile telephones are multichannel systems which carry both network traffic and traffic intended for that particular telephone. Accordingly, the more telephones that are part of the network, the greater the network capacity to route data to a desired destination. Moreover, each mobile telephone will be available for routing network data independently of whether it is receiving data on the private channel. Indeed, when the private channel or channels are not being used, they too are used to carry network traffic.

It will be appreciated that although only three nodes are illustrated in Figure 1, the invention is applicable to networks having more than three nodes. More particularly, and as will be understood form the teaching in this specification, preferred embodiments of the invention will accommodate considerable numbers of nodes without being limited by the bandwidth considerations suffered by the prior art networks. It will also be

appreciated by those skilled in the art by the teaching herein that the capacity of the network to accommodate users is not limited by the maximum circuit capacity or fixed aggregate bandwidth of a node, as network traffic is simply re-routed through other nodes should any particular node be operating at capacity. The prior art networks, however are limited by the maximum capacity of a single base station to transmit the desired information.

Preferably, the signal sent by one node to another includes both address information and message information. The address information is, in some embodiments, the information corresponding to the address assigned to a particular node and which is the ultimate destination node for the message information. In other embodiments, however, the address information corresponds to the address assigned to the node which is to next receive the signal. In still further embodiments, the network operates according to a 'virtual circuit' concept where links go through a setup and tear down process as required. This is similar to existing time division voice networks. In other embodiments the addresses specify circuit identifiers or packet headers with source destination addresses. Again, all these different modes of operation are encompassed by the present invention.

A particularly preferred transmission method for commercial wireless networks is cell based transmission. That is, fixed length packets or 'cells' which are hardware switched with the deterministic delays required for voice transport. Moreover, the cells also support segmentation and reassembly of variable length packets as used in TCP/IP networks. Furthermore, such network architecture supports hybrid time division multiplexed digital switching fabrics embedded in the reconfigurable array along with

variable length packet based routed channels. The latter approach allows for optimal allocation of voice and data resources and a migration path from legacy networks although not inherently supporting the full multimedia integration possible with the fixed length cell based link protocols.

Telephones 2, 3 and 4 are in a reconfigurable mesh network architecture such that each node is able to communicate a data signal having message information and address information with any other node in the network. However, this communication occurs at both a public and a private level. Each node has a specific address within the network which is designated in the address information of any data signal. Accordingly, a data signal will be transmitted into the network using the public channel. As the data signal progresses through the network it is inspected at each node to determine whether the address information corresponds to the address of the respective node. If so, the message information is extracted by the node. Otherwise, the data signal is passed to another node and onward toward its intended destination node. In some embodiments the data signal is one of a plurality of data signals provided by one node which collectively contain a message. Once sufficient of the signals are received at the destination node, the respective message information is extracted and sequenced to construct the message.

In the illustrated embodiment, telephone 2 and 4 are logged onto network 1 and configured to communicate with telephone 3. In other embodiments, node 2 is also configured to communicate with a number of other nodes (not shown) either simultaneously or sequentially.

As to which of the other nodes in the network that telephone 2 communicates with is determined on a signal strength basis. That is, once telephone 2 is switched on and in transmission range of any one or more other nodes in network 1, it determines the identity of those nodes and electronically configures itself to communicate with them and become part of the network. Accordingly, in circumstances where telephone 2 is "out of range" of a node that is a base station and yet within transmission and reception range of a node that is, say, telephone 3, then communication will be established with telephone 3 and the network enlarged to include telephone 1.

The nodes also include the necessary circuitry and software to ensure adequate handoff capability. This is of particular importance for two nodes that are moving relative to each other.

All the nodes in network 1 periodically investigate the network and to establish the nodes which are juxtaposed such that the signal strength will allow effective communication therebetween. Accordingly, the network is continually and dynamically reconfiguring itself based upon the geographical disposition of the mobile and/or stationary nodes.

As the density of the network increases each node need only communicate with the two or three closest adjacent nodes. However, as a whole, nodes will be continually entering and exiting the network and, as such, a continual reconfiguration will occur.

Referring to Figure 2 there is illustrated a block diagram of a node of network 1 in the form of a mobile telephone 10. In this case, the network nodes are connected via an analog channel and, as such, telephone 10 includes an analog to digital converter 11 to provide the digital inputs a reconfigurable array 13. The outputs of array 13 drive a

digital to analog converter circuit 12. As discussed further below, array 13 is programmed to provide one of a multitude of functions that are dynamically varied to accommodate the vast range of adaptability required by telephone 10.

Array 13 accommodates real time sequential and parallel implementation of the circuitry blocks that are required to integrate telephone 10 into the multichannel communication network. That is, the array processor creates a first circuitry block to perform a required operation and, while that operation is being performed, creates a second circuitry block to receive the output of the first block. If necessary the processor array stores the output in an intermediate buffer. As will be appreciated by those skilled in the art, a number of different circuitry blocks are able to be created in parallel and series to perform the required operations. Preferably, the array processor creates, in parallel, a plurality of circuitry blocks, each operating on a signal for a respective channel of the multichannel network that is established through telephone 10.

Turning once again to Figure 2, array 13 is monitored and reprogrammed by a microprocessor 14 which, in accordance with the present processing requirements of the array, fetches circuit configuration templates from a nonvolatile memory 15. These templates include encoded instructions for connecting the logic cells of array 13 into predetermined circuits for performing the functions necessary at that time. While in this embodiment the functions are executed synchronously within the array, in other embodiments this occurs asynchronously in serial or in parallel fashion. Moreover, in other less preferred embodiments, telephone 11 includes dedicated circuitry outside of array 13 for performing predetermined communications functions.

It will be understood that the components of the telephone illustrated in Figure 2 are, in other embodiments, implemented as separate integrated circuits. Further embodiments include these components as templates which are stored in memory 15 and physically embodied, as required, within some portion of array 13.

In circumstances where array 13 is large enough, the entire integrated circuit requirements are embodied in templates and selectively given form by the array.

Figure 3 schematically illustrates a mobile telephone 20 where the reconfigurable gate array processor has been configured to operate as a OFDMA/CDMA transceiver. More particularly, telephone 20 includes a media access front end 1. This front end includes an antenna, a bandpass filter, and a low noise amplifier. The output signal from the amplifier is provided to an analog to digital converter 2. As would be appreciated, such a receiver must provide n-point inverse fast Fourier transforms 3 and n separate sliding window correlator functions 4, where n is the number of active connections that telephone 21 has with adjacent nodes. Moreover, as stated above, n varies greatly over time. This does not, however pose a difficulty for telephone 20, as the reconfigurable network processor dynamically provides the required number of channels to correspond to the number of active node connections. That is, if a small number of active connections or channels are desired, each of those channels will enjoy the use of a large fraction of the available bandwidth of the medium. Alternatively, if the network traffic for a large number of users must be routed through telephone 20, each of the channels provided by the array processor will be a small fraction of the total channel capacity. Clearly, any combination in the continuum between these extremes is achievable.

Configuration and reconfiguration is established in real-time and, as such, the performance limitation of task-switching, as experienced in software based implementations, is avoided. Moreover, such an arrangement has a clear advantage over known designs which have a fixed number of user ports embodied in hardware.

The converse of the above also applies. If a particular user desires a large bandwidth this is provided. While this would at first appear to slow the network considerable, the effect is reduced as the remaining information is routed to its destination via an alternative series of nodes.

The maximum number of users connected to the network or the number of signal processing functions able to be performed on a data stream is a function of the speed and size of the memory storing the configuration templates and the time required to achieve partial or full reconfiguration. Once the array is initially configured, however, stable real-time performance is assured. In the prior art, the maximum number of users is predetermined by the number of physical receive or transmit circuits in hardware implementations or the variable task switching speed of relatively slow software based implementations.

As described with reference to Figures 2 and 3, it is preferable that each node in network 1 contains an in-circuit reconfigurable array processor including thousands of logic gates which are selectively configured to operate as one or ore of a plurality of digital transceivers and routing circuits. The configuration is driven by a microprocessor executing a software program which is responsive to various inputs including, in some embodiments, a centralised network control. In some embodiments, a plurality of such transceivers operate in parallel within the reconfigurable gate array processor, one

allocated for each active connection to a network node. As nodes leave the network, the circuits are deconfigured or reassigned to new nodes entering the network. In this manner a flexible network architecture is achieved with high throughput, redundancy and diversity for mitigating the effect of bit error rates in the channel.

The number of network ports is dynamically reconfigurable. Any given node is configured to perform network functions such as routing traffic to a greater or lesser degree concurrently with other network functions such as originating or receiving communications as required by the network requirements in the locale of the node.

Each node entering the network adds one unit of public network "infrastructure" circuitry and one unit of private originate and receive user network access circuitry. The two units operate in full duplex, or on a time shared basis in simplex implementations where one receiver and one receiver is time shared between these roles. In the preferred embodiments this feature ensures that the network's capability to service the traffic is commensurate with the capacity to load the network with traffic in any given area. Since the concentration of network traffic is linked to the location and concentration of user nodes originating and receiving traffic, this also ensures the automatic deployment of network infrastructure where it is needed on a dynamic basis. This flexibility is an advantage over all conventional network architectures which must be designed for peak load conditions.

The embodiments described provide an effective solution to the problem of allocating bandwidth where and when it is needed and is completely scalable to the physical limits on spatial diversity and the power, bandwidth and interference limited capacity of the medium. As the concentration of nodes increases the distances between

nodes generally decreases and, consequently, the power output of each node is reduced to increase spatial diversity by reducing the total noise power and internode interference. A densely interconnected mesh configuration is the result with a multitude of network paths available to traffic streams incoming and outgoing from a given network sector.

Since a connection between two non- adjacent nodes cannot be closed unless both a transmitter and receiver are available, the preferred embodiments guarantees the availability of through links by pairing the receive and transmit channels of nearby nodes. The maximum number of nodes denied access to a through traffic public channel will not exceed n modulo 2, or 1, where n is the number of nodes within range in an arbitrary region of the network service area. Thus, the network is consistently non-blocking despite the dynamic variations in network traffic distribution.

Preferably, use is made of orthogonal code division multiple access (CDMA) and orthogonal frequency division multiple access (OFDMA) techniques to eliminate the need for frequency reuse planning of shared media. The advantages of these techniques will be apparent to those skilled in the art.

The reconfigurable array processor, in some embodiments, implements a large number of parallel receivers, one or more for each active node. Where more than one receiver is tracking the signal from one node the multipath channel delays are exploited to achieve a diversity gain, that is to say the signal is accumulated over several propagation paths between the transmitter and receiver and thereby enhanced.

Channel equalisation algorithms are also used in some embodiments in real time to match the fluctuating channel conditions which change on a wide range of time scales from microseconds to years.

The templates stored in the nonvolatile memory encode logic circuits for performing functions in the gate array including one or more or the following functions: n-point discrete Fourier transforms; inverse n-point discrete Fourier transforms; pseudo random code generation;, correlation;, channel equalisation algorithms; wavelet transformations, DPSK modulation and demodulation; QPSK modulation and demodulation; GMSK modulation and demodulation; PPM modulation and demodulation; PWM modulation and demodulation; M-ary modulation and demodulation; direct digital frequency synthesising; filtering; power control for the front end media access circuits; forward error correction; and many others not explicitly named but apparent to those skilled in the art. It is intended that any such additional functions which could be encoded for reconfiguration of a field programmable logic gate array are to be included within the scope of the invention. The invention allows for loading of other circuit configurations throughout the service life of the node.

It will also be appreciated that many of the functions referred to above necessitate rapid and multiple multiplication operations which are time consuming and processor intensive. In cases where the multiple calculations include a built in redundancy or are otherwise reducible to simpler addition operations, the appropriate template is supplied to the array processor. In situations such as filtering this often results in significantly less gates in the array being used for that operation and, as such, more of the gates being available for performing a different function. Accordingly, not only is less time taken to achieve the calculation itself, other activities are carried out in parallel.

The preferred embodiments allow the combining of the advantages of both application specific integrated circuits and general purpose digital signal processors

without suffering from their disadvantages. That is, the high speed of application specific integrated circuits is combined with the flexibility of digital signal processor and microprocessor architectures in a compact universal design. This is achieved, however, without the inflexibility of the specific circuits or the relatively slow performance of the signal processors.

In the described embodiments multiple link protocols, media access protocols and "air interface" standards are accommodated by dynamically reconfiguring the network node as needed. For example, when the user is roaming between heterogeneous network service areas the templates are varied to provide a seamless means of communication to the user.

In some preferred embodiments some or all of the reconfigurable array processor is dynamically configured as a neural network to simulate the communications network. It operates as an associative memory which learns to identify any suboptimal routes even though they appear locally to be optimal.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that it may be embodied in many other forms.

CLAIMS:-

1. A communications network including a plurality of network nodes each having at least one public channel for routing data within the network and at least one private channel for originating and receiving data for its respective node, each node being dynamically reconfigurable such that its connection with one or more other nodes within the network is dynamically allocated when the node first enters the network.

2. A network according to claim 1 wherein at least one of the plurality of nodes is simultaneously interconnected to more than one of the other nodes.

3. A network according to claim 1 or claim 2 wherein the at least one node is connected to a plurality of adjacent nodes to facilitate transmission power requirements.

4. A network according to claim 1 wherein the at least one public channel and the at least one private channel function in duplex.

5. A network according to claim 1 wherein the at least one public channel and the at least one private channel function in simplex.

6. A network according to claim 1 wherein each node includes an in-circuit reconfigurable gate array processor for configuring respective nodes.

7. A network according to claim 6 wherein the reconfigurable gate array processor includes a plurality of logic cells.

8. A network according to claim 6 or claim 7 wherein the reconfigurable gate array processor is in electrical communication with and configured by a processor executing a software program.

9. A network according to claim 6 wherein the reconfigurable gate array processor operates as a plurality of digital transceivers and routing circuits.

10. A network according to claim 8 wherein the processor controlling the reconfigurable gate array processor is in electrical communication with a non-volatile memory means for providing predetermined access to a plurality of node configuration templates, the microprocessor selectively implementing one or more of the plurality of templates in the reconfigurable gate array processor logic cells.

11. A network according to claim 10 wherein the circuit configuration templates are loaded into the reconfigurable gate array processor under software control for allowing channel equalisation algorithms to be adapted in real time to match fluctuating channel conditions.

12. A network according to claim 9 wherein the nodes configured for routing or carriage services are such that when the node carries en route through traffic destined for nodes other than the current node, received signals are regenerated and retransmitted to the next node in the network route.

13. A network according to claim 1 wherein the nodes are dynamically reconfigured to accommodate a plurality of telecommunication protocols or media access protocols.

14. A network according to claim 1 wherein the nodes are dynamically reconfigured to accommodate a plurality of air interface standards to allow a user to roam between heterogenous network service areas.

15. A network according to claim 6 wherein the reconfigurable gate array processor operates in a parallel with a digital transceiver such that one transceiver is allocated for each active connection of the respective node to another node in the network.

16. A network according to claim 6 wherein the reconfigurable gate array processor of a node leaving the network is deconfigured or reassigned to a new node entering the network.

17. A network according to claim 6 wherein the reconfigurable gate array processor for a particular node is configured to implement a number of parallel receivers, at least one for each active node associated with that particular node.

18. A network according to claim 1 which operates with radio frequency waves.

19. A network according to claim 1 which is cellular.

20. A network according to claim 1 which is configured for digital communication.

21. A network according to claim 1 wherein the plurality of nodes are movable.

22. A network according to claim 1 or claim 21 wherein at least some of the nodes are stationary.

23. A network according to claim 22 wherein the movable nodes are respective mobile telephones and the stationary nodes are base stations.

24. A network according to claim 6 wherein the reconfigurable gate array processor is configured to operate as a OFDMA/CDMA transceiver.

25. A network according to claim 6 wherein the templates allow the reconfigurable gate array processor to dynamically perform one or more of the following functions: n-point inverse fast Fourier transform; inverse n-point discrete Fourier transform; a pseudo random code generation; correlation; channel equalisation; wavelet transformation; DPSK modulation and demodulation; QPSK modulation and demodulation; GMSK modulation and demodulation; PPM modulation and demodulation; PWM modulation and demodulation; M-ary modulation and

demodulation; direct digital frequency synthesising; filtering; control of the front end media access circuits; and forward error correction.

26. A network according to claim 25 wherein two or more of the functions are performed simultaneously.

27. A network according to claim 1 wherein each node is dynamically reconfigurable such that its connection with one or more other nodes within the network is dynamically allocated in response to one or more of the following:

the geographic location of the node with respect to any other node; and

the number and bandwidth of the public and private channels.

28. A communications device for a communications network including a plurality of communication nodes, the device including:

first means for establishing communication between the device and at least two nodes in the network and for receiving from those nodes a first data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

second means for generating a second data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

third means for providing the first data signal to one of the at least two nodes such that the data signal is communicated to the node in the network which corresponds to the address information; and

fourth means for receiving the first data signal and, if the address information corresponds to the device, extracting the message information, or otherwise communicating the first signal to the other of the at least two nodes.

29. A device according to claim 28 wherein the first means establishes communication with more than two nodes and in circumstances where the fourth means communicates the first signal, that communication is provided to only one of the other nodes.

30. A device according to claim 28 wherein the first data signal is coded to prevent extraction of the message information by a node other than that corresponding to the address information.

31. A method of communication utilising a communications device in a communications network including a plurality of communication nodes, the method including the steps of:

establishing communication between the device and at least two nodes in the network and for receiving from those nodes a first data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

generating a second data signal having address information and message information wherein the address information corresponds to one of the nodes in the network;

providing the first data signal to one of the at least two nodes such that the data signal is communicated to the node in the network which corresponds to the address information; and

receiving the first data signal with the device and, if the address information corresponds to the device, extracting the message information or, otherwise, communicating the first signal to the other of the at least two nodes.

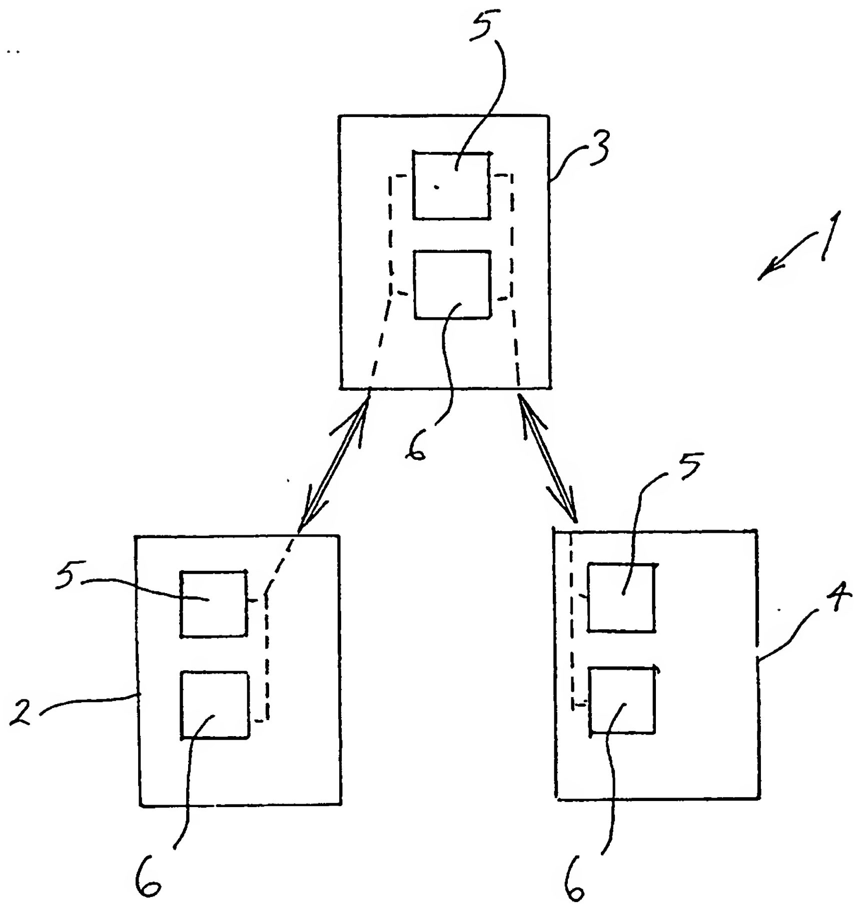

Figure 1

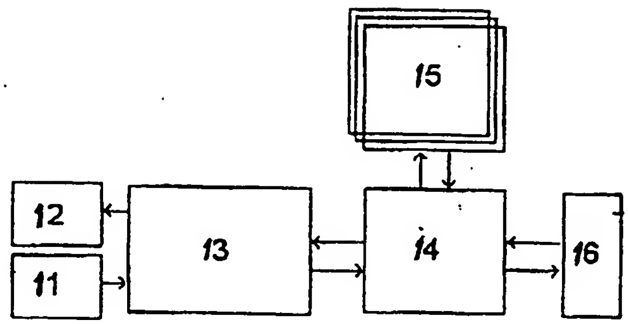

Fig. 2

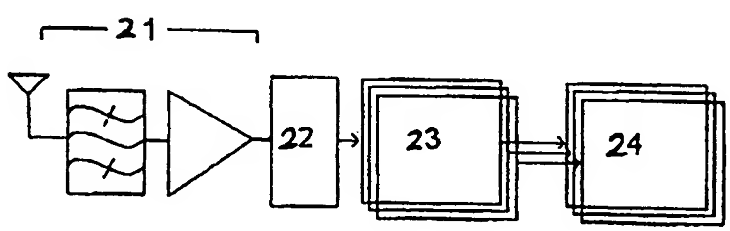

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00412

A.	CLASSIFICATION OF SUBJECT MATTER
Int Cl[6]:	H04Q 7/22, 7/32, H04B 7/204

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC H04Q 7/--, H04B 7/--, H04L 5/--, H04L 12/--, H04J 5/--

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU IPC AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT, IBM Patent Miner, US Patent Full Text Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	"MOBILE NETWORKING THROUGH MOBILE IP" CHARLES E. PERKINS, IEEE INTERNET COMPUTING, Vol. 2 no.1 January - February 1998, pp 58 - 69.	1 to 21, 23 to 30 22
X A	"DHCP for MOBILE NETWORKING WITH TCP/IP" CHARLES E. PERKINS et al. Proceedings IEEE International Symposium Systems and Communication., June 1995 pp 255 -261.	1 to 21, 23 to 30 22

☐ Further documents are listed in the continuation of Box C

☐ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 July 1999	13 JUL 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00412

Box 1 **Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:

because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II **Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Claims 1 to 26 define a communication network wherein each of a plurality of nodes has at least one public channel for routing data within the network, and at least one private channel for originating or receiving data. Each of these nodes are dynamically configured/allocated when the node first enter the network which is considered to comprise a first "special technical feature".

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Box

Continuation of Box II

Claims 27 to 30 appear to attempt to define a device for use in a communications network. The device includes a first means for receiving a first data signal, a second means for generating a second data signal, a third means for transmitting the first data signal to at least two nodes and a fourth means for determining to extract the message or forward it onto at least two nodes which is considered to comprise a second "special technical feature".

Since the above mentioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.